

# CONTENTS

PAGE

AUTHOR(S)

## 2007 AGENT-DIRECTED SIMULATION SYMPOSIUM (ADS'07)

ADS'07 Preface	3	
ADS'07 International Program Committee	4	
ADS'07 Tutorial: Modeling and Simulation with the Brahms Agent Environment	5	Maarten Sierhuis Chin Seah
<b>AGENT TAXONOMIES</b>		
Towards a Taxonomy of Agents and Multi-Agent Systems	11	Lisa Jean Moya Andreas Tolk
An Ontology-Based Dictionary of Understanding as a Basis for Software Agents with Understanding Abilities	19	Tuncer I. Ören Nasser Ghassem-Aghaee Levent Yilmaz
Taxonomy for the Modeling and Simulation of Emergent Behavior Systems	28	O. Thomas Holland
<b>APPLICATIONS I</b>		
A Hybrid Simulation Model for Studying Acute Inflammatory Response	39	Wayne Wakeland Louis Macovsky Gary An
Simulation Monitoring Using Intelligent Mobile Agent Technology	47	Bob DeAnna Bob Peterson
Agent-based Simulation of Shuttle Mission Operations	53	Maarten Sierhuis Thomas E. Diegelman Chin Seah Valerie Shalin William J. Clancey Albert M. Selvin
<b>AGENT ARCHITECTURES AND COORDINATION MODELS</b>		
An Agent-Supported Simulation Architecture for Manufacturing Systems	63	Nancy Ruiz Adriana Giret Vicente Botti
Fighting Fire with Agents - An Agent Coordination Model for Simulated Firefighting	71	Daniel Moura Eugénio Oliveira
An Agent-Supported Simulation Framework for Metric-Aware Dynamic Fidelity Modeling	79	A. K. Castner I. A. Chukhman E. J. Colbert M. E. Dale B. Y. Lewis D. R. Zaret

# CONTENTS

PAGE

AUTHOR(S)

## APPLICATIONS II

Consideration of Fluctuation and Factors in Election with a Simulation Model	89	3 Teruhiko Yoneyama Mukkai S. Krishnamoorthy
Exploring the Impact of Employee Turnover on the Effectiveness of Software Development Team Archetypes	94	Levent Yilmaz
Human Behavior And Social Network Simulation: Fuzzy Sets/Logic And Agents-Based Approach	102	Elkosantini Sabeur Gien Denis

## AGENT ORGANIZATION MODELING

Using the MANA Agent-Based Simulation Tool to Evaluate and Compare the Effectiveness of Ground-Based and Airborne Communications Jammers in Countering the IED Threat to Ground Convoys	113	Umit Ayvaz Murat Dere Yao Ming Tiah
Agent-based Modeling of Interdependencies in Critical Infrastructures through UML	119	Valeria Cardellini Emiliano Casalicchio Emanuele Galli
Evolving Multi-Agent Network Structure with Organizational Learning	127	Il-Chul Moon Kathleen M. Carley

## APPLICATIONS III

The Mind Agents in Netlogo 3.1	137	Sule Yildirim Gregory L. Dam James C. Houk
Towards understanding: A study of the SourceForge.net community using modeling and simulation	145	Yongqin Gao Greg Madey
A Physics Model for the RoboCup 3D Soccer Simulation	151	Carlos Bustamante César Flores Leonardo Garrido

## FORMAL MODELS

Complexities of Simulating a Hybrid Agent-Landscape Model Using Multi-Formalism Composability	161	Gary R. Mayer Hessam S. Sarjoughian
Genetic Algorithms for Agent-Based Infrastructure Interdependency Modeling and Analysis	169	May Robin Permann
Understanding Organizational Congruence: Formal model and simulation framework	178	Virginia Dignum Frank Dignum
An Exposure Study of Technology Transaction	185	Hui-Hua Ou-Yang

# ADS'07 PREFACE

On behalf of the organizing committee of the 2007 Agent-directed Simulation Symposium (ADSS), we wish to welcome you to Norfolk, VA, USA. ADSS is taking place within the 2007 Spring Simulation Multiconference, which is sponsored by the Society for Modeling and Simulation International in collaboration with ACM/SIGSIM. This year ADSS is also co-sponsored by the McLeod Modeling and Simulation Network (M&SNet), which is a consortium of cooperating independent organizations active in professionalism, research, education, and knowledge dissemination in the modeling and simulation (M&S) domain.

The growth of new advanced distributed computing standards along with the rapid rise of e-commerce is providing a new context that acts as a critical driver for the development of next generation systems. These standards revolve around service-oriented technologies, pervasive computing, web-services, Grid, autonomic computing, ambient intelligence etc. The supporting role that intelligent agents play in the development of such systems is becoming pervasive, and simulation plays a critical role in the analysis and design of such and many other types of systems.

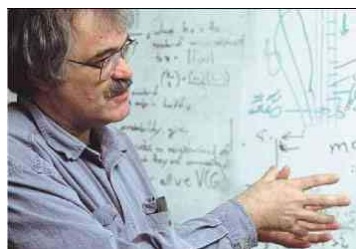
Currently, there exist many agent symposia, as well as agent-based social simulation conferences. However, there are not many simulation conferences where agent and simulation technology are together a central theme. It is therefore that the ADS symposium fills a gap in the agent community as well as the simulation community. Through the theme of agent-directed simulation (with emphases to agent simulation and agent-based as well as agent-supported simulations), the symposium will bring together agent technologies, tools, toolkits, platforms, languages, methodologies, and applications in a pragmatic manner. In this symposium, established researchers, educators, and students are encouraged to come together and discuss the benefits of agent technology in their use and application for simulation. It is a way for people to discuss why and how they have used agent technology in their simulations, and describe the benefit of having done so.

Many people contributed to making ADS 2007 a success. The efforts of the Scientific Program Committee and referees were instrumental in shaping the program by facilitating the peer-review process as well as in supporting the organization of the symposium. We extend our sincere thanks to the ADS 2007 authors. Also, Dr. Maarten Sierhuis and Chin Seah from NASA Ames Research Center kindly accepted our invitation to deliver a tutorial on their widely accepted and successful simulation development environment: BRAHMS. Finally, we would like to thank Wayne Ingalls, who supervised the production of the proceedings with great professionalism. Given the quality of the papers submitted to this year's symposium, we are hopeful that future ADS symposiums will continue to build on this success to emerge as a platform that hosts a variety of workshops related to theory, methodology, and applications of agent-directed simulation. On behalf of the conference organizers and the Scientific Program Committee, we hope everyone enjoys this year's outstanding program.

Sincerely,



Dr. Tuncer Ören  
*General Chair*



Dr. Gregory R. Madey  
*Symposium Co-chair*



Dr. Maarten Sierhuis  
*Symposium Co-chair*



Dr. Levent Yilmaz  
*Symposium Co-chair*

# ADS'07 PROGRAM COMMITTEE

---

## International Program Committee

- [Fernando Barros](#), University of Coimbra, Portugal
- [Martin Butz](#), University of Würzburg, Germany
- [Kathleen Carley](#), Carnegie Mellon University, USA
- [Rosario Conte](#), National Research Council, Italy
- [Paul Davis](#), RAND and RAND Graduate School, USA
- [Julie Dugdale](#), Institut de Recherche en Informatique de Toulouse, France
- [Bernard Espinasse](#), Université d'Aix-Marseille, France
- [Paul Fishwick](#), University of Florida, USA
- [Claudia Frydman](#), LSIS, France
- [Norbert Giambiasi](#), LSIS, France
- [Henry Hexmoor](#), Southern Illinois University at Carbondale, USA
- [John Hiles](#), MOVES Institute, USA
- [Xiaolin Hu](#), Georgia State University, USA
- [C. Anthony Hunt](#), UCSF, USA
- [Marco Janssen](#), Indiana University, USA
- [Christine Lisetti](#), Institut Eurecom, France
- [Desmond Saunders-Newton](#), USC and DARPA-IAO, USA
- [Ernest Page](#), The MITRE Corporation, USA
- [Paolo Petta](#), Centre for Brain Research, Medical University of Vienna, Austria
- [Glen Ropella](#), UCSF, USA
- [Charles Santoni](#), LSIS, France
- [Hessam Sarjoughian](#), Arizona State University, USA
- [Jeffrey Schamburg](#), U.S. Army TRAC - Monterey, USA
- [Maarten Sierhuis](#), RIACS/NASA Ames Research Center, USA
- [Simone Simeoni](#), Liophant, Italy
- [Jeffrey Smith](#), Auburn University, USA
- [Boleslaw Szymanski](#), Rensselaer Polytechnic Institute, USA
- [Andreas Tolk](#), VMASC - Old Dominion University, USA
- [Gabriel Wainer](#), Carleton University, Canada

# ADS'07 TUTORIAL SESSIONS

---

## Modeling and Simulation with the Brahms Agent Environment

### Tutorial Sessions

#### Presenters

*Maarten Sierhuis, Ph.D.*

USRA/RIACS - NASA Ames Research Center

[Maarten.Sierhuis-1@nasa.gov](mailto:Maarten.Sierhuis-1@nasa.gov)

*Chin Seah*

SAIC- NASA Ames Research Center

[cseah@mail.arc.nasa.gov](mailto:cseah@mail.arc.nasa.gov)

#### What is Brahms?

Brahms (<http://www.agentisolutions.com>) is an agent-based modeling and simulation environment

- a. for developing simulations of people, organizations, objects such as tools, documents and systems and
- b. for designing, simulating and implementing multi-agent software systems.

The Brahms environment includes an agent-oriented language, compiler and virtual machine, as well as a development environment and a post-execution viewer of agent execution, communication and interaction. Brahms models are not like traditional task or functional analysis of work processes that leave out people's practices, especially how environmental conditions come to be detected and how problems are resolved. Cognitive modeling tools (e.g. SOAR, ACT-R) focus on detailed modeling of individual cognitive tasks. In contrast, Brahms focuses on how informal, circumstantial, and located behaviors of a group of individuals interact, where communication and synchronization occurs, such that the task contributions of people and machines flow together to accomplish goals. Brahms can also be used to design and implement software agents that incorporate models of people's work practice. Brahms enables the creation of multi-agent models that include aspects of reasoning found in cognitive models, task execution, plus the impact of geography, such as agent movement and physical changes in the environment.

## What will be part of the Brahms Tutorial?

The tutorial will provide an overview of the Brahms language using the development environment and post-execution viewer. By considering a simple "*day in the life of a student*" scenario we will show the use of Brahms as an agent-based modeling and simulation tool.

### 1.1.1.1. Requirements:

Attendees are *strongly* encouraged to bring a laptop running Microsoft XP to install Brahms, view the model and run a simulation.

### 1.1.1.2. Handouts:

1. A set of presentation slides (created in Microsoft PowerPoint™) to accompany the lecture
2. A CD containing the Brahms environment, documentation of tutorial, Brahms tutorial model & simulation and the Brahms website (<http://www.agentisolutions.com>).

## References

- [1] Alessandro Acquisti, William J. Clancey, Ron van Hoof, Mike Scott & Maarten Sierhuis: "Brahms Tutorial", [http://www.agentisolutions.com/documentation/tutorial/tt\\_title.htm](http://www.agentisolutions.com/documentation/tutorial/tt_title.htm), Version 1.0, July 2003.
- [2] Clancey, W. J. (2002). "Simulating Activities: Relating Motives, Deliberation, and Attentive Coordination." *Cognitive Systems Research*, 3(3), 471-499.
- [3] Clancey, W. J., Sachs, P., Sierhuis, M., and van Hoof, R. (1998). "Brahms: Simulating practice for work systems design." *International Journal on Human-Computer Studies*, 49, 831-865.
- [4] Sierhuis, M. (2001). "Modeling and Simulating Work Practice; Brahms: A multiagent modeling and simulation language for work system analysis and design," Ph.D. thesis, University of Amsterdam, SIKS Dissertation Series No. 2001-10, Amsterdam, The Netherlands.
- [5] Sierhuis, M., and Clancey, W. J. (2002). "Modeling and Simulating Work Practice: A human-centered method for work systems design." *IEEE Intelligent Systems*, Volume 17(5)(Special Issue on Human-Centered Computing).
- [6] Sierhuis, M., Clancey, W. J., Seah, C., Trimble, J. P., and Sims, M. H. (2003). "Modeling and Simulation for Mission Operations Work System Design." *Journal of Management Information Systems*, Vol. 19(No. 4), 85-129.

## **Presenters Biographies**

*MAARTEN SIERHUIS* is a senior research scientist at the Research Institute for Advanced Computer Science (RIACS is an institute of the Universities Space Research Association at NASA Ames Research Center), where he manages the Brahms project on modeling and simulating work practice. His research interests are agent-oriented languages and their application to the development of human-centered systems. Before joining RIACS, he was a member of the Work Systems Design group and the Expert Systems laboratory of NYNEX Science & Technology. He also developed expert systems as a senior knowledge engineer at IBM and in the Netherlands. He received an engineering degree in Higher Informatics from the Hague Polytechnic and a Ph.D. from the Department of Social Science Informatics at the University of Amsterdam.

*CHIN SEAH* is a computer scientist at Science Applications International Corporation (SAIC), working at NASA Ames Research Center on the Brahms project. He is applying the Brahms work system design and modeling approach to the MER mission operations system. Before joining the Brahms team, he worked as a business process management consultant at Andersen Consulting and as a knowledge engineer at Mindbox, Inc. implementing rule-based and case-based expert systems. He has a B.S. in computer engineering from Santa Clara University and an M.S. in computer information science from the University of Pennsylvania where he did research in natural language processing and computer graphics.

# CONTENTS

PAGE

AUTHOR(S)

## 2007 DEVS INTEGRATIVE M&S SYMPOSIUM (DEVS'07)

DEVS'07 Preface	195	
DEVS'07 Symposium Organization	196	
<b>DEVS FOUNDATIONS</b>		
System Modeling with Mixed Object and Data Models	199	Hessam Sarjoughian Robert Flasher
Discrete event modeling through a multi-formalism approach, from a user-oriented perspective	207	Hernán P. Dacharry Norbert Giambiasi
Easy DEVS	214	Mamadou Kaba Traoré
<b>MODELING AND SIMULATION METHODS: PART 1</b>		
DEVS/NS-2 Environment; Integrated Tool for Efficient Networks Modeling and Simulation	219	Taekyu Kim Moon Ho Hwang Doohwan Kim Bernard P. Zeigler
LSIS_DME M&S Environment Extended by Dynamic Hierarchical Structure DEVS Modeling Approach	227	Lassaad Baati Claudia Frydman Norbert Giambiasi
CD++Builder: An Eclipse-Based IDE For DEVS Modeling	235	Chiril Chidisiuc Gabriel A. Wainer
<b>MODELING AND SIMULATION METHODS: PART 2</b>		
Experimental Frame Structuring and Aggregation of Source Data: Application to US Climate Normals	243	Saecheon Cheon Bernard P Zeigler
Parallel and distributed simulation of Parallel DEVS models	249	Jan Himmelspach Roland Ewald Stefan Leye Adeline M. Uhrmacher
The event queue problem and PDEVS	257	Jan Himmelspach Adeline M. Uhrmacher



# CONTENTS

PAGE

AUTHOR(S)

## COLLABORATIVE EXECUTION AND SYSTEM MODELING OVER SOA

<b>Studying the Impact of Web-Services Implementation of Distributed Simulation of DEVS and Cell-DEVS Models</b>	<b>267</b>	<b>Rami Madhoun Gabriel Wainer</b>
<b>A W3C XML Schema for DEVS Scenarios</b>	<b>279</b>	<b>J. L. Risco Martín Saurabh Mittal M. A. López-Peña J. M. de la Cruz</b>
<b>DEVSMML: Automating DEVS Execution Over SOA Towards Transparent Simulators</b>	<b>287</b>	<b>Saurabh Mittal José Luis Risco-Martín Bernard P. Zeigler</b>

## APPLICATIONS

<b>Modelling &amp; Simulation oriented components of Wireless Sensor Network using DEVS formalism.</b>	<b>299</b>	<b>T. Antoine-Santoni J.F. Santucci E. De Gentili B. Costa</b>
<b>Analysis of a submarine's evasive capability against an antisubmarine warfare torpedo using DEVS modeling and simulation</b>	<b>307</b>	<b>Doo-Yeoun Cho Myeong-Jo Son Jung-Ho Kang Sung-Jun Lee Ju-Hwan Cha Seong-Jin Yoo Hyo-Kwang Lee Kyu-Yeul Lee Tae-Wan Kim Yong-Seog Ko</b>
<b>Complex System Simulation: DEVS Implementation of the valley fever model</b>	<b>316</b>	<b>R. Jammalamadaka B.P. Zeigler M. Zhang M. E. Gettings M. Bultman</b>
<b>Simulation-based Architectural Design and Implementation of a Real-time Collaborative Editing System</b>	<b>320</b>	<b>Jon A Preston Xiaolin Hu Sushil K Prasad</b>

# DEVS'07 PREFACE

---

Welcome to the third DEVS Integrative M&S Symposium (DEVS'07), which is part of the 2007 Spring Simulation Multi-conference sponsored by the Society for Modeling and Simulation International. The goal of this annual DEVS Integrative M&S Symposium is to foster continuing research and to promote broader practice of DEVS based modeling and simulation.

This year's symposium exhibits a wide variety of topics, including modeling and simulation methods, simulation over SOA, formal analysis, modeling and simulation environments, and several applications of DEVS based modeling and simulation. Web-based modeling and simulation, and the role of Service Oriented Architectures in large scale M&S projects, has received particular attention this year. In fact, a special session on Collaborative Execution and Systems Modeling over SOA is devoted to this topic.

Many people have contributed to making DEVS 2007 a success. We thank all the authors, steering committee, program committee, and referees for their efforts. Thanks also to Wayne Ingalls and other SCS staff members who helped to make this Symposium, and the entire SpringSim event, a success. The DEVS Symposium continues to grow, attracting a broad variety of researchers. We hope that the DEVS Symposia will continue to grow and emerge as a major forum for presenting and promoting research on DEVS-based modeling and simulation. A webpage for the symposium (at <http://www.ornl.gov/~1qn/DEVS>) has been setup to help publicize and consolidate these efforts. We look forward to your on-going contributions to future DEVS Symposiums!

James Nutaro and Xiaolin Hu  
DEVS 2007 Program Chairs

# DEVS'07 SYMPOSIUM ORGANIZATION

---

## 2007 DEVS Symposium Organization

### General Chair:

**James Nutaro**, Oak Ridge National Laboratory, USA

### Program Chair:

**Xiaolin Hu**, Georgia State University, USA

### Technical Committee:

**Jon Cline**, Case Western Reserve University

**Phil Hammonds**, Northrop Grumman Information Systems

**Moon Hwang**, University of Arizona

**Rajanikanth Jammalamadaka**, University of Arizona

**DH Kim**, RTSync

**Ernesto Kofman**, Universidad Nacional de Rosario

**Eddie Mak**, Raytheon Missile Systems

**Saurabh Mittal**, University of Arizona

**Alex Muzy**, Università di Corsica

**Lewis Ntaimo**, Texas A&M University

**Trevor Pearce**, Carleton University

**Hessam Sarjoughian**, Arizona State University

**Mamadou Traoré**, ISIMA

**Hans Vangheluwe**, McGill University

**Gabriel Wainer**, Carleton University

**Bernard Zeigler**, University of Arizona

**Ming Zhang**, University of Arizona

# CONTENTS

PAGE

AUTHOR(S)

## 2007 HIGH PERFORMANCE COMPUTING SYMPOSIUM (HPC'07)

HPC'07 Preface	331	
HPC'07 Organizing Committee	332	
HPC'07 Keynote Address: Mathematical Software for High-end Computational Science and Engineering	333	David Keyes
<b>HIGH PERFORMANCE APPLICATIONS</b>		
Fusing and Composing Macromolecular Regulatory Network Models	337	Ranjit Randhawa Clifford A. Shaffer John J. Tyson
Biomolecular Network Simulator: Software for Stochastic Simulation of Cellular Biological Processes	345	Yaroslav Chushak Brent Foy John Frazier
Performance of Stabilized Explicit Time Integration Methods for Parallel Air Quality Models	350	Anurag Srivastava John C. Linford Adrian Sandu
<b>PROBLEM-SOLVING ENVIRONMENTS AND HIGH PERFORMANCE SOFTWARE TOOLS</b>		
Simulation of a Complex Distributed Real-Time Database System	359	Waqar Haque Paul R. Stokes
Dynamic Scheduling in Parallel Answer Set Programming Solvers	367	Hung Viet Le Enrico Pontelli
Overcoming the processor communication overhead in MPI applications	375	Gabriel Mateescu
<b>COMPONENT-BASED HIGH PERFORMANCE APPLICATIONS</b>		
Application of the Salome Software Architecture to Nuclear Reactor Research	383	V. Bergeaud M. Tajchman
A Hybrid Decomposition Scheme for Building Scientific Workflows	388	Wei Lu Kenneth Chiu Satoshi Shirasuna Dennis Gannon
Analyzing the Impact of Computational Heterogeneity on Runtime Performance of Parallel Scientific Components	395	Sumir Chandra Manish Parashar Jaideep Ray

# CONTENTS

PAGE

AUTHOR(S)

## PARALLEL ALGORITHMS AND ARCHITECTURES

<b>A Shared Memory Parallel Algorithm for Hybrid Image Classification</b>	<b>405</b>	<b>R. D. Phillips L. T. Watson R. H. Wynney</b>
<b>Optimization Algorithms for Multi-Service IP Network Planning</b>	<b>412</b>	<b>Thi-Thanh-Mai Hoang</b>
<b>Experimental Evaluation of Infiniband Transport over Local- and Wide-Area Networks</b>	<b>419</b>	<b>Steven Carter Makia Minich Nageswara S. V. Rao</b>

## GRID COMPUTING

<b>2-step Algorithm for Enhancing Effectiveness of Sender-based Message Logging</b>	<b>429</b>	<b>Jinho Ahn</b>
<b>C++ Reflection for High Performance Problem Solving Environments</b>	<b>435</b>	<b>Tharaka Devadithya Kenneth Chiu Wei Lu</b>
<b>BXSA for Fast Processing of Scientific Data</b>	<b>441</b>	<b>Tharaka Devadithya Zongde Liu Nayef Abu-Ghazaleh Wei Lu Kenneth Chiu Stephane Ethier</b>

# HPC'07 PREFACE

---

Welcome to the 15th High Performance Computing Symposium (HPC 2007), devoted to the impact of high performance computing and communications on computer simulations, held as part of the 2007 Spring Simulation Multiconference (SMC'07).

Advances in networking, high end computers, large data stores, and middleware capabilities are ushering in a new era of high performance parallel and distributed simulations. However, along with these opportunities come new challenges. The goal of this 2007 symposium is to encourage innovation in high performance computing and communication technologies and to stimulate the use of these technologies in key areas of computer simulation. It will promote the exchange of ideas and information between universities, industry, and national laboratories through the development of high performance computing and communication applications that, in turn, can provide solutions to current scientific and technical challenges. Broad areas of interest include high performance applications, high performance software tools, distributed and grid computing, visualization and data management, problem solving environments, parallel algorithms and architectures, and high performance discrete event simulation.

HPC 2007 is the 15th in a series of international symposia aimed at promoting the exchange of ideas, information, and novel developments among universities, national laboratories, and industry. This year's symposium features a keynote lecture by David Keyes of Columbia, and a special session on component-based high performance applications organized by Masha Sosonkina. The high quality papers that appear in these proceedings were thoroughly refereed, and represent a diverse set of high performance computing and communications topics. Some papers in the DEVS Integrative Modeling and Simulation Symposium and the Business and Industry Symposium may also be of interest to HPC2007 attendees.

This event and program would not have been possible without the dedicated efforts of the steering and program committees. We are grateful to the program committee for their timely reviewing and work in assembling such an excellent program, and to the authors who submitted the high quality material from which that program was selected. We also thank the members of the steering committee, especially Manish Parashar of Rutgers and Andreas Stathopoulos of the College of William and Mary, for their guidance and advice. Those at SCS involved in the organization and production details, notably Steve Branch and Wayne Ingalls, were indispensable in making everything happen on time.

Again, we welcome you to Norfolk and hope that you will find HPC 2007 an interesting and rewarding event.

Layne T. Watson  
HPC 2007 General Chair

Tomasz Haupt, Clifford A. Shaffer, Masha Sosonkina  
HPC 2007 Program Co-chairs

# HPC'07 ORGANIZING COMMITTEE

---

## GENERAL CHAIR

- **Layne Watson**, Virginia Tech, USA

## STEERING COMMITTEE

- **Srinivas Aluru**, Iowa State University, USA
- **Brett Bode**, Ames Laboratory, USA
- **Boyana Norris**, Argonne National Laboratory, USA
- **Manish Parashar**, Rutgers University, USA
- **Andreas Stathopoulos**, College of William and Mary, USA

## PROGRAM CO-CHAIRS

- **Tomasz Haupt**, Mississippi State University, USA
- **Cliff Sha**
- **Masha Soffer**, Virginia Tech, USA  
**Asonkina**, Ames Laboratory, USA

## PROGRAM COMMITTEE

- **Gabrielle Allen**, Louisiana State University, USA
- **Raymond Bair**, Argonne National Laboratory, USA
- **Ioana Banicescu**, Mississippi State University, USA
- **Umit Catalyurek**, Ohio State University, USA
- **Nikos Chrisochoides**, College of William and Mary, USA
- **Maurice Clint**, Queen's University, UK
- **Jose Cunha**, Universidade Nova de Lisboa, CITI, Portugal
- **Ewa Deelman**, University of Southern California, USA
- **Nahid Emad**, University of Versailles, France
- **Daniel Grosu**, Wayne State University, USA
- **Ricky Kendall**, Ames Laboratory, USA
- **Tahsin Kurc**, Ohio State University, USA
- **Tong Liu**, Dell, USA
- **Gabriel Mateescu**, NRC Canada, Canada
- **Kumar Matinthakumar**, North Carolina State University, USA
- **Joerg Meyer**, University of California, Irvine, USA
- **Jun Ni**, University of Iowa, USA
- **Suely Oliveira**, University of Iowa, USA
- **Marlon Pierce**, Indiana University, USA
- **Thomas Rauber**, University of Bayreuth, Germany
- **Calvin Ribbens**, Virginia Tech, USA
- **Gudula Ruenger**, Technical University of Chemnitz, Germany
- **Adrian Sandu**, Virginia Tech, USA
- **Alan Stewart**, Queen's University Belfast, UK
- **Alan Sussman**, University of Maryland, USA
- **Adrian Tentner**, Argonne National Laboratory, USA
- **Virginia Torczon**, College of William and Mary, USA
- **Gregor von Laszewski**, Argonne National Laboratory, USA
- **Pak Chung Wong**, Pacific Northwest National Laboratory, USA
- **Albert Zomaya**, University of Sydney, Australia

# HPC'07 KEYNOTE ADDRESS

---



## **Mathematical Software for High-end Computational Science and Engineering**

**David Keyes**

**Fu Foundation Professor of Applied Mathematics,  
Columbia University**

Multiscale, multirate scientific and engineering applications based on systems of partial differential equations possess resolution requirements that are typically inexhaustible and demand execution on the highest-capability computers available, which will soon reach the petascale. While the variety of applications is enormous, their needs for mathematical software infrastructure are surprisingly coincident. Domains with complex geometry require versatile meshing and discretization tools. Resolution requirements that evolve with the solution require dynamic adaptivity. Implicit methods for stable and accurate integration of transient problems and efficient treatments for equilibrium problems lead to large, ill-conditioned algebraic systems that must be solved with an algorithmic complexity that is close to linear in problem size or storage complexity. Distributed memory architectures demand efficient means of creating and managing load-balanced partitions of unstructured objects. These and other algorithmic challenges that are generic to nearly all mesh- and particle-based applications are addressed in the SciDAC Institute and Centers for Enabling Technologies in mathematics, which we briefly overview in this talk.

The chief to bottleneck to scalability is often the solver. At their current scalability limits, many applications spend a vast majority of their operations in solvers, due to solver algorithmic complexity that is superlinear in the problem size, whereas other phases scale linearly. Furthermore, the solver may be the phase of the simulation with the poorest parallel scalability, due to intrinsic global dependencies. The Towards Optimal PDE Simulations (TOPS) center focuses on relieving this bottleneck while providing a multilevel programming interface that allows users to advance from initial concerns of correctness and robustness to ultimate concerns of efficiency and performance portability.

David E. Keyes is the Fu Foundation Professor of Applied Mathematics in the Department of Applied Physics and Applied Mathematics at Columbia University, an affiliate of the Center for Data Intensive Computing (CDIC) at Brookhaven National Laboratory, and Acting Director of Institute for Scientific Computing Research (ISCR) at the Lawrence Livermore National Laboratory.